

POROUS MICRONEEDLE PATCHES FOR THERAPEUTIC MONITORING OF PARKINSON'S TREATMENTS

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INTRODUCTION

Parkinson's Disease is a progressive disorder that affects the nervous system and the parts of the body controlled by the nerves. Common Treatments for Parkinson's include the prescription of Carbidopa and Levodopa. The combined use of these drugs can mitigate symptoms of Parkinson's. However, these drugs have a narrow therapeutically relevant range. Thus, adjusting to a proper dosage is essential for effective treatment.

CURRENT METHOD: CLINICAL TESTING

Outline of Method:

- Patient gives sample for testing at clinic
- Sample goes to a lab for analysis
- Lab results allow medical professionals to adjust dosage

Problems with Current Method:

- Costly
- Significant delay for results (days to weeks)
- Limited testing means limited data

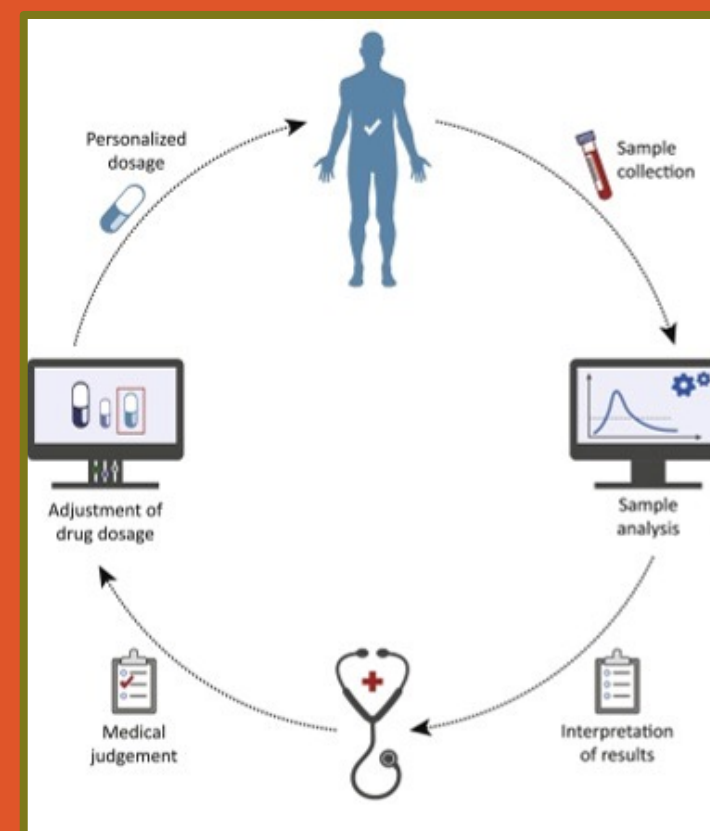


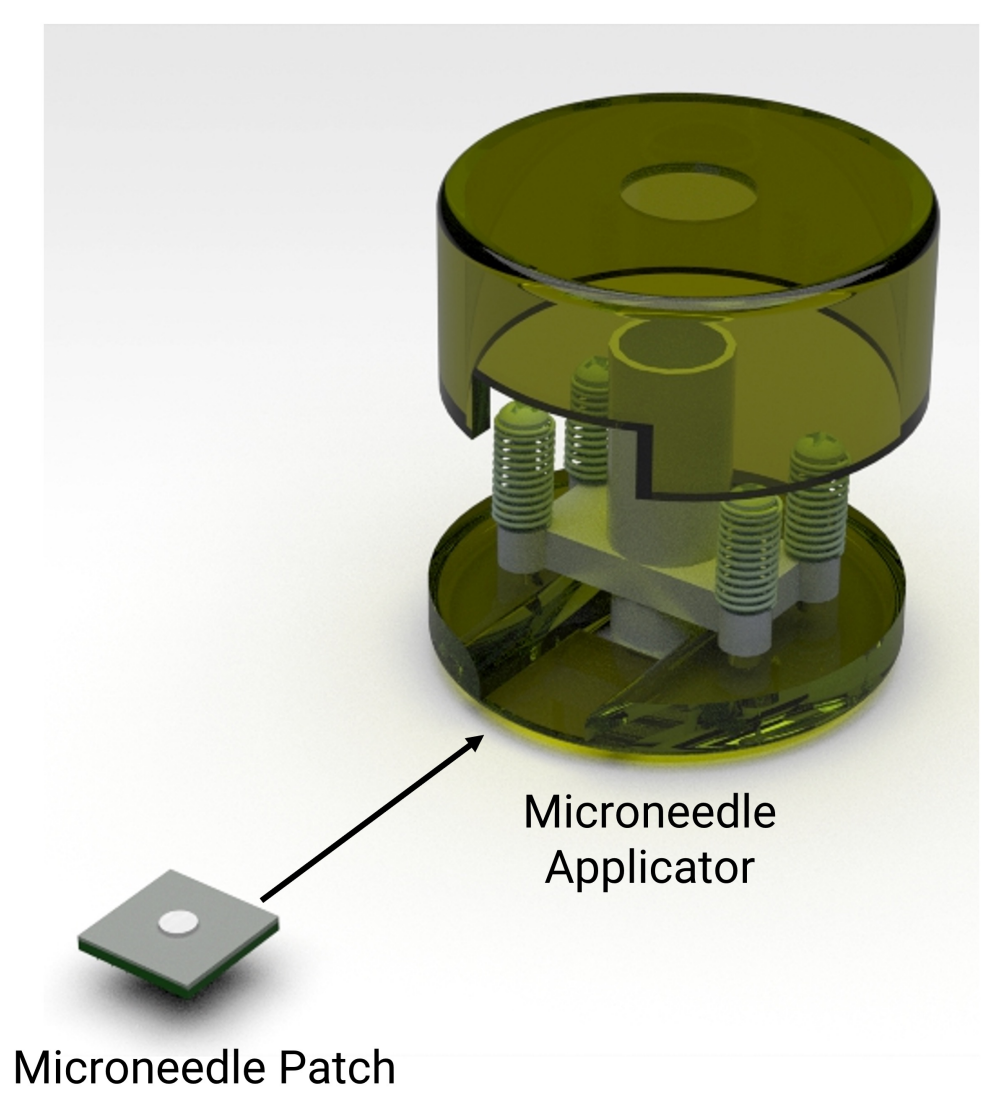
Fig 2. Therapeutic Drug Monitoring

PROPOSED SOLUTION: POINT-OF-CARE DIAGNOSTIC DEVICE

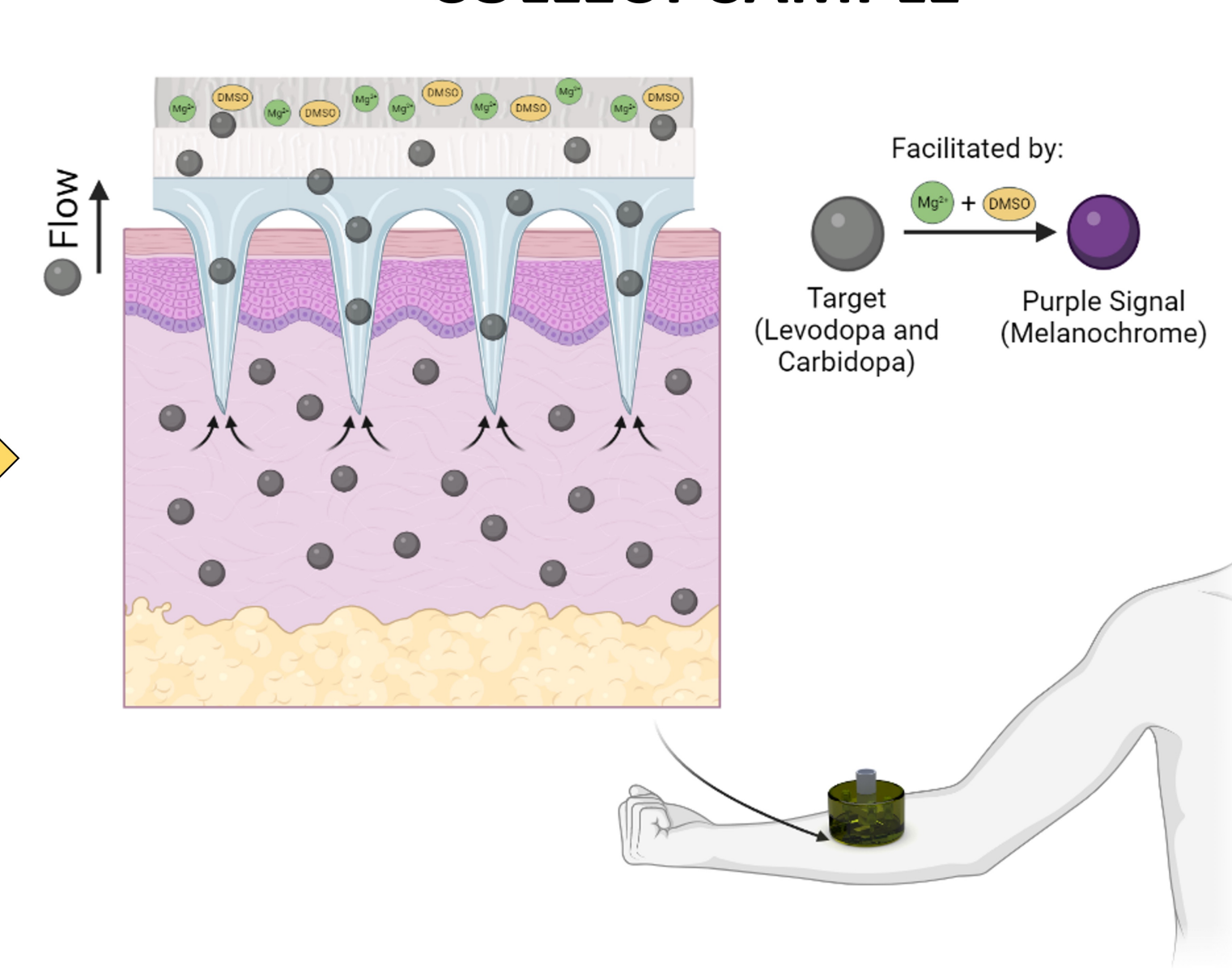
Advantages Over Current Method:

- Easier access to testing (test at home)
- Rapid results (minutes)
- Ability to test frequently allows for patient-specific trends

LOADING MICRONEEDLE PATCH



COLLECT SAMPLE



ANALYZE CONCENTRATION

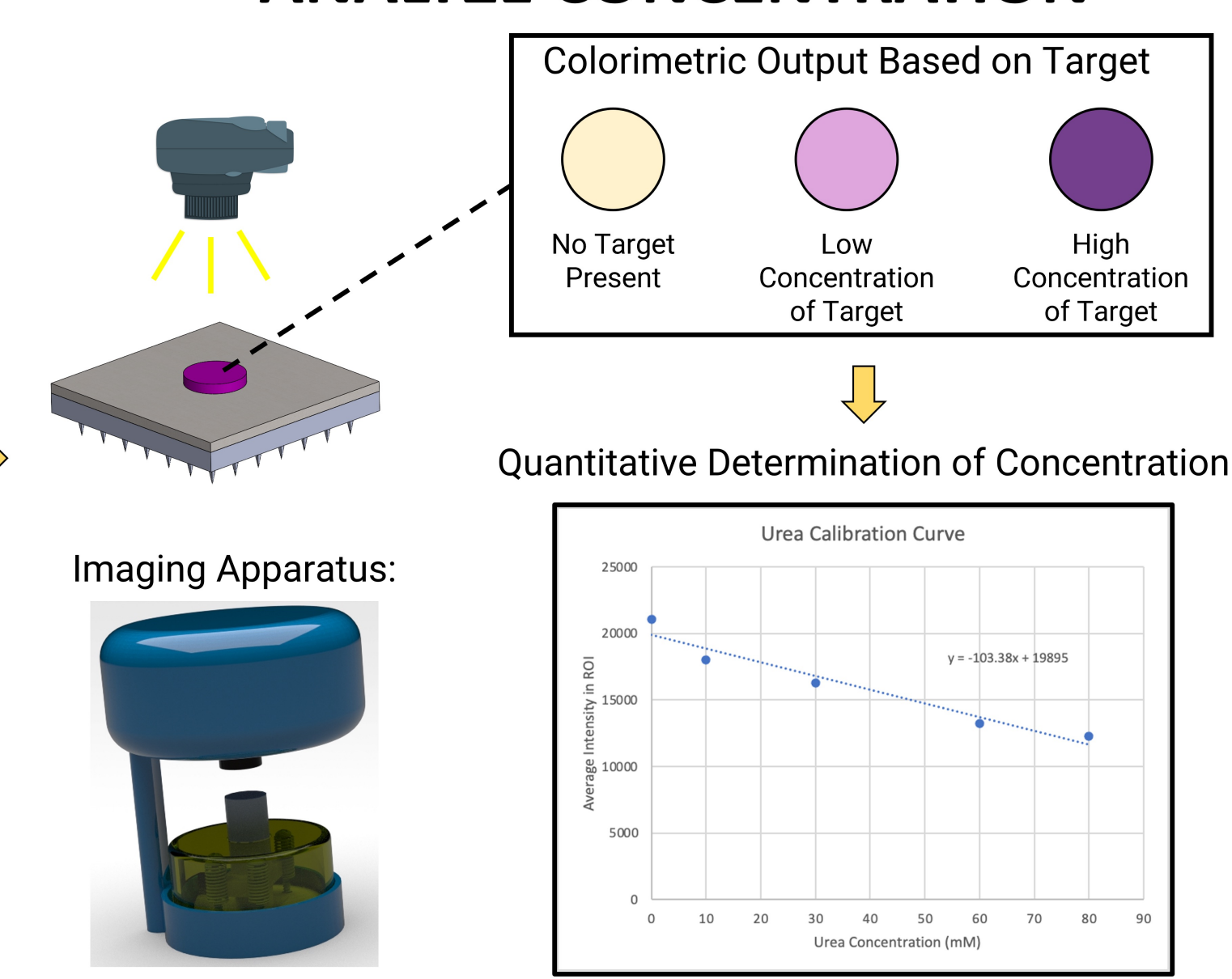


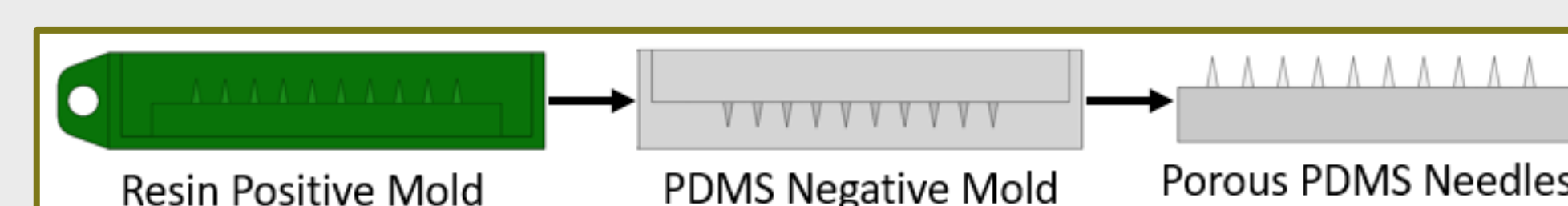
Fig. 1. Overview of Device Operation

RESULTS

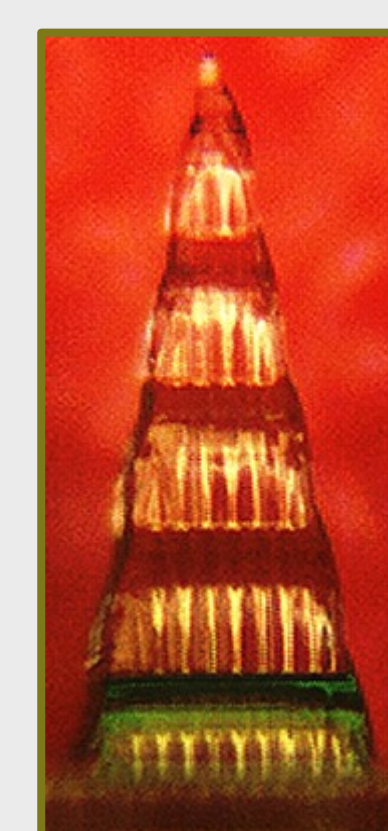
Porous Microneedles:

Purpose: To puncture the patient's epidermal layer into the dermis to gather a sample of interstitial fluid.

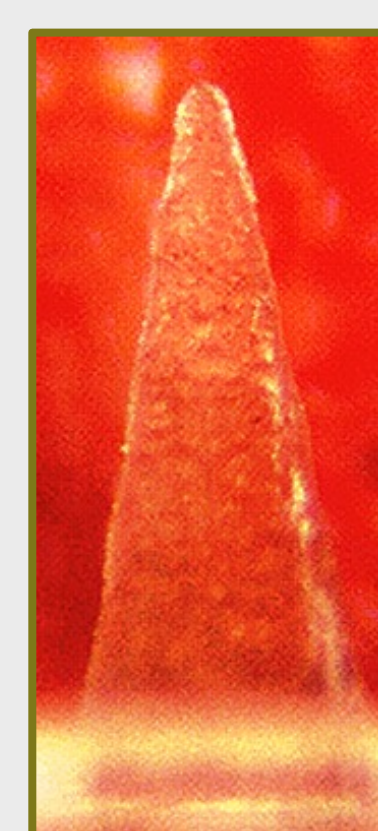
FABRICATION PROCEDURE



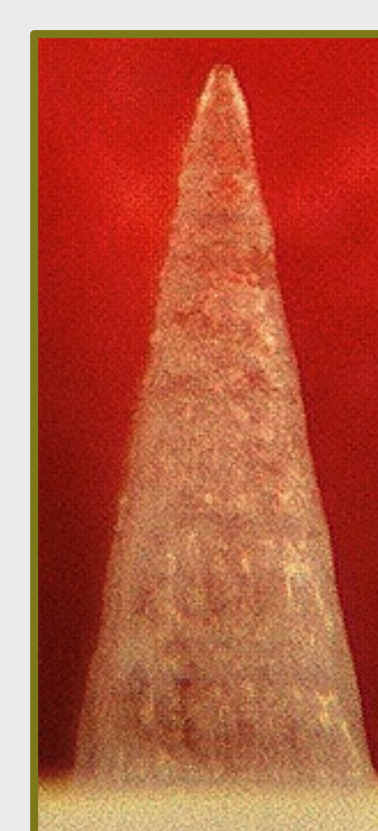
MICRONEEDLE IMAGES



3D Printed Microneedle



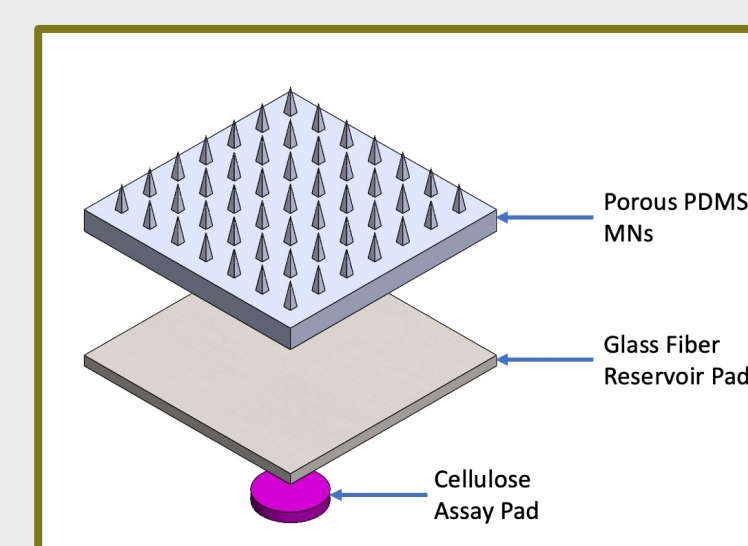
PDMS Microneedle



Porous PDMS Microneedle

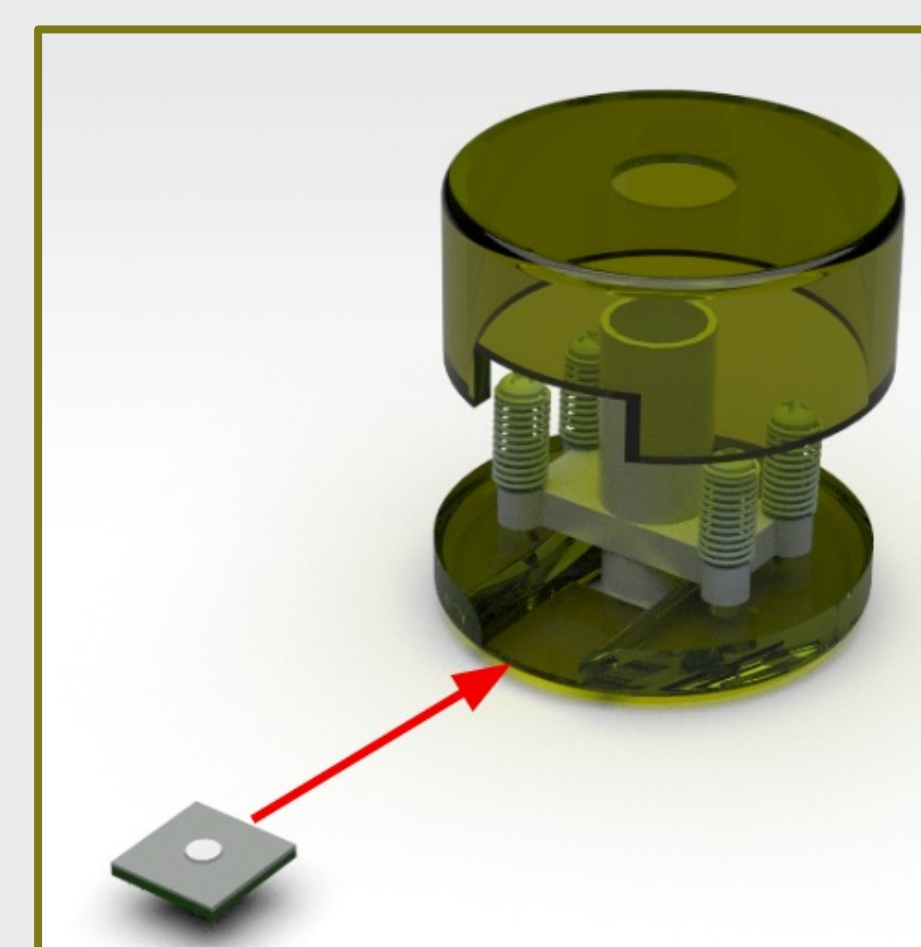
Microneedle Wicking Pad:

Purpose: To wick up the interstitial fluid sample from the microneedle array and to create a colorimetric signal using dried-down reagents within the pad.

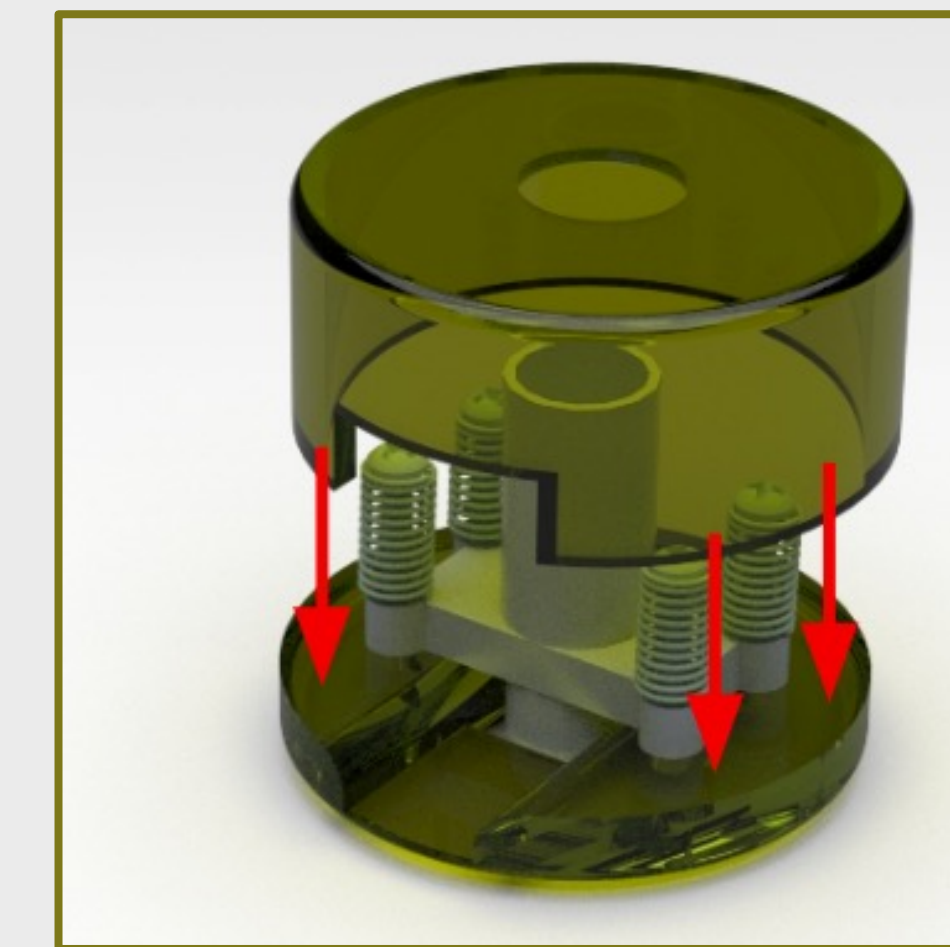


Applicator Device:

Purpose: To insert the microneedle array into the patient with a controlled, uniform force.



Step 1. Load microneedle patch into the applicator



Step 2. Place the applicator on the patient's forearm and firmly press the top of the applicator down to insert the microneedles

Imaging Apparatus:

Purpose: To collect image data for quantification of colorimetric output which is correlated to the concentration of the target in the sample

EXAMPLE OUTPUT IMAGES

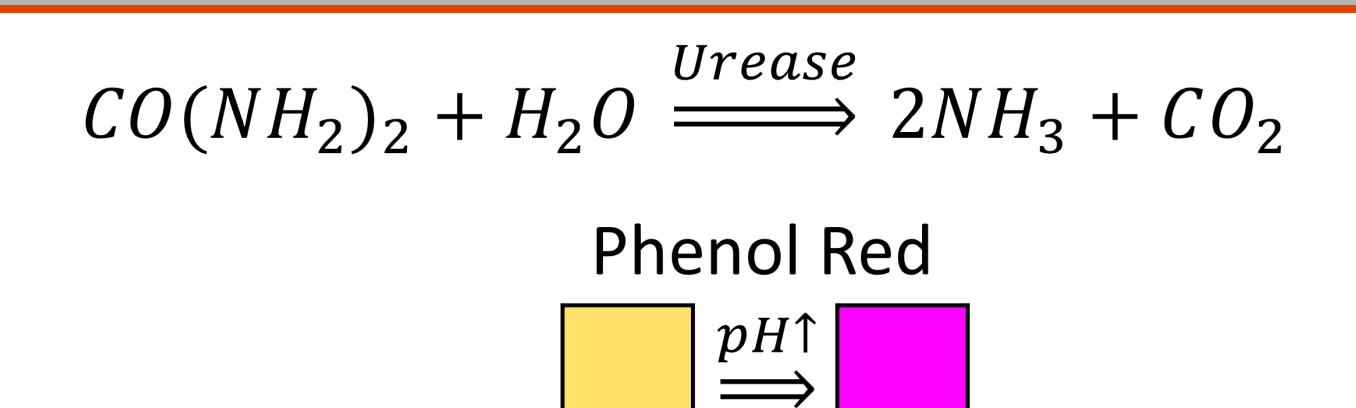


PROOF OF CONCEPT: UREA ASSAY

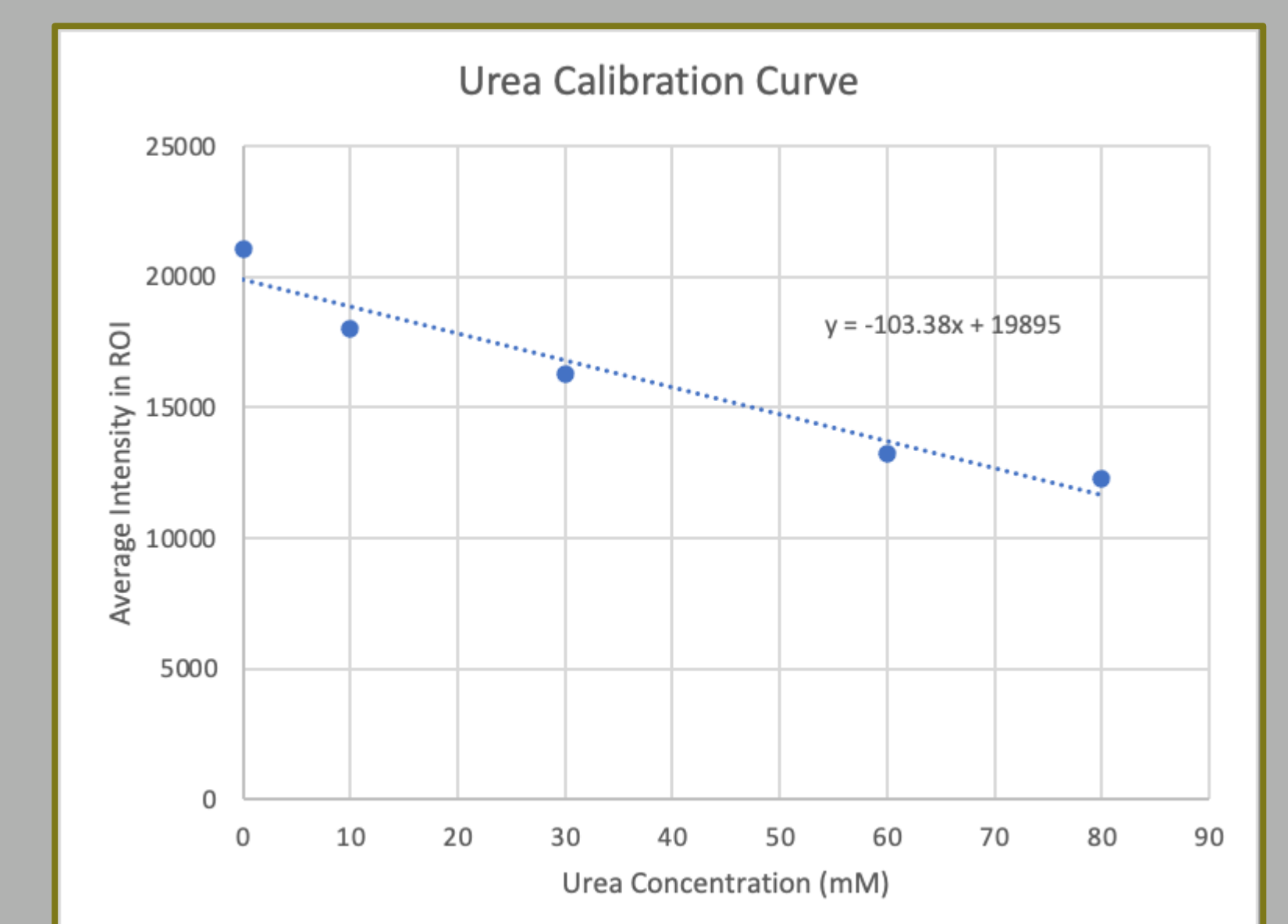
Purpose: To Showcase our device in a mock colorimetric assay

- It is hard to obtain pharmaceutical drugs for testing, so a similar colorimetric assay was used.
- Urea is an analyte present in interstitial fluid and can be used to produce a similar colorimetric output as the oxidation of Carbidopa/Levodopa.
- In this assay, urea and water are broken down into ammonia and carbon dioxide, facilitated by the enzyme urease. Ammonia raised the pH, changing the color of phenol red to purple.
- Clinically-relevant concentrations of urea were tested: **0 mM** (negative control), **14 mM** (gen. pop.), **66 mM** (chronic renal failure)

UREA ASSAY MECHANISM



UREA ASSAY MECHANISM

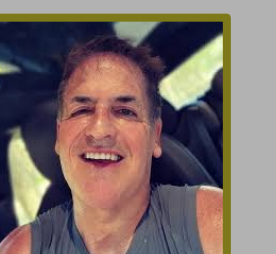


SUMMARY

- We developed a Point-of-Care diagnostic device for determining concentrations of drugs used to treat Parkinson's disease.
- We prototyped several aspects of the device, including the microneedle array, the microneedle wicking pad, the applicator device, and the imaging apparatus.

ACKNOWLEDGEMENTS

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